Oxidation of C^{14}-Glucose by the Aestivating Snail *Pila globosa* (Swainson)

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INTRODUCTION

The Indian apple-snail *Pila* provides an interesting case for the study of aestivation. In summer months when the ponds, streams and paddy fields inhabited by this snail dry up, it retires into deeper layers of the mud, withdraws its body into the shell, closes the shell aperture with the operculum and enters into a state of dormancy until the advent of rain (Prashad, 1925; Saxena, 1955; Meenakshi, 1956a, 1964). It has been reported that this snail can aestivate for one year or more if the conditions in the environment demand. Based on manometric experiments and on the ability of the snail to aestivate in plastimould for several months, Meenakshi (1956b, 1956c, 1957) concluded that the aestivating *Pila virens* does not consume oxygen. She also reported progressive depletion of the glycogen reserves and accumulation of lactic acid in tissues during aestivation, followed by a repayment of oxygen debt during revival in the post-aestivation period. On the basis of these observations, Meenakshi concluded that metabolism in the aestivating *Pila virens* is entirely anaerobic. On the other hand, Coles (1968) has recently reported that the related species *P. ovata* from Africa is aerobic during aestivation and shows measurable oxygen consumption in manometric experiments. We report here that the aestivating *Pila globosa* (Say, 1822) oxidizes C^{14}-glucose to $C^{14}O_2$ and hence is aerobic.

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MATERIAL AND METHODS

Snails aestivating for 3 months in dry mud in large wooden boxes in the laboratory (Saxena, 1956) were used in the experiments. A small hole was drilled into the operculum of the aestivating snail and 1 microcurie of U-C^{14}-glucose was injected into the foot of the snail through this hole with a Hamilton microsyringe. Immediately a little plasticene was applied to the hole to prevent any oozing out of fluids, and sealed with melted wax. The CO_2 liberated by 4 such snails was trapped in 50 ml of saturated KOH as described by Hu (1958) and Bergreen, Meenakshi & Scheer (1961). The CO_2 in 2 ml aliquots of KOH taken at daily intervals for 5 days was precipitated as $BaCO_3$. After repeated washing, the precipitate was suspended in 95% ethanol and plated on stainless steel planchets for counting of radioactivity on thin window GM counters (Atomic Energy Commission, Trombay, India).

RESULTS AND DISCUSSION

The experiment was repeated thrice and the results of a typical experiment given in Table 1 show that there is significant radioactivity in $BaCO_3$ precipitates. It is evident from these results that the aestivating snail is putting out $C^{14}O_2$ and thus has the potentiality to oxidize glucose to CO_2. These results also suggest that lactic acid, which according to Meenakshi (1956a, 1956b, 1957) accumulates in the snail tissues during aestivation, is not the only end product of glucose metabolism in the aestivating *Pila globosa*.

Table 1

$C^{14}O_2$ output by aestivating snails injected with C^{14}-glucose

Days after injection	cpm/2ml KOH [1]
1 day	1199
2 days	1267
3 days	1785
4 days	1972
5 days	2109

[1] corrected for the background counts

Probably pyruvate resulting from the glycolysis of glucose in the aestivating snail is partly reduced to lactate and partly oxidized to CO_2 and water via the Krebs' cycle. It is also possible that some glucose in the aestivating snail is channeled through the hexose monophosphate shunt pathway resulting in the production of labeled CO_2. Thus the output of $C^{14}O_2$ suggests that the aestivating *Pila globosa* is aerobic. The activity of respiratory enzymes is reduced by 50 to 60% only in the tissues of aestivating *Pila globosa* (Reddy, 1967). Thus it is likely that metabolism in the aestivating *P. globosa,* though at a depressed level, is at least partially aerobic as shown by Coles (1968) in the case of *P. ovata.* The failure of Meenakshi (1956a, 1957) to measure any oxygen consumption in aestivating *P. virens* may be due to the reason that the mercury manometers she used are not sensitive enough to detect the minute gaseous exchange occurring in the snail during this torpid state.

Meenakshi (1956a, 1957, 1964) considers that the shell of *Pila* does not permit gaseous exchange and the closure of the shell opening with the operculum during aestivation is airtight. *Pila globosa* loses weight during aestivation; this weight loss is too high to be explained in terms of the depletion in the nutritional reserves of the body and hence should be due to water loss (Reddy, 1965). The related species *P. ovata* respires, though at a reduced rate, during aestivation (Coles, 1968). Speeg & Campbell (1968) reported that the shell of the terrestrial snails *Otala lactea* and *Helix aspersa* permits diffusion of gaseous ammonia. These reports as well as the output of $C^{14}O_2$ by the aestivating *P. globosa* reported here suggest that either the shell of this snail is pervious to gases or the closure of the shell opening with the operculum during aestivation is not air-tight, or both. Hence we suggest that this snail aestivates both under aerobic and anoxic conditions metabolizing glucose to lactic acid when oxygen is not available as during burial in the plastimould (Meenakshi, 1956a, 1956b, 1956c, 1957, 1964) and at least partially to CO_2 when oxygen is available in the environment. Further experiments on the pathways of glucose metabolism in active and aestivating snails should be of interest.

SUMMARY

Aestivating *Pila globosa* injected with C^{14}-glucose produced $C^{14}O_2$. Metabolism in this snail during aestivation is at least partly oxidative and not entirely anaerobic as claimed by other workers.

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